RESEARCH ON TEMPERATURE DEPENDENCE ON SURFACE TENSION OF CATIONS SURFACE ACTIVE SUBSTANCES

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Abstract: *The object of this research paper is cation surface active substances, used for disinfection. The experiments were conducted in pure original laboratory conditions at different temperature and concentration intervals. The propounded methodology and experimental results are applicable to assess the operational qualities of disinfecting substances.*

Keywords: SURFACE TENSION, SURFACE ACTIVE SUBSTANCES.

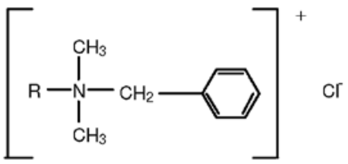
1. Introduction

Eliminating the consequences of biological contamination is often realized with the help of cationic surface active substances. Surface tension is a parameter directly connected with the quality of disinfection.

The objective of this research is to test the surface tension of the disinfecting components at different temperature and concentration intervals.

2. Objects of testing are the following cationic surface active substances:

1) n – Alkyl Dimetyl Benzil Ammonium Chloride /BTC-50E/ - pertaining to the group of Ammonium compounds with the following graphic formula:



BTC- 50E possesses a wide specter of bactericidal, fungicidal and virucide activities and it is used to disinfect equipment in food industry, transportation vehicles etc. Its most important parameters are shown in Table1. [1, 3, 5, 6, 7]

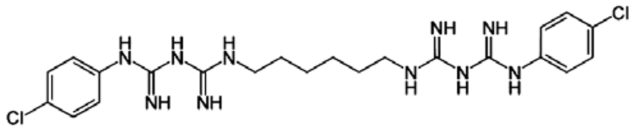
Table 1: *Typical properties of BTC- 50E.*

properties	amounts
Appearance at 25°C	clear liquid
pH, 5% aqueous	7.5
Colour, Klett value	max 150
Density, g/cm^3	1.000
Viscosity, (Brookfield LVT1, V60), mPa.s	130
Flash point, SETA, °C	>100
Amine + chlorhydrate , %	<1

2/Clorhexidine gluconate- it is used for producing pharmaceutical and cosmetic products with fast bactericidal activity and long-lasting bacteriostasic activity which is a result of adsorption on the surfaces. [1,3] Chlorhexidine is active against gram-positive and gram-negative organisms, facultative anaerobes, aerobes, and yeast. It is particularly effective against gram-positive bacteria (in concentrations ≥ 1 μg/l). Significantly higher concentrations (10 to more than 73 μg/ml) are required for gram-negative bacteria and fungi. In the presence of blood or protein the efficacy is reduced by a factor of 100 to 1000. Chlorhexidine is ineffective against polioviruses and adenoviruses. The effectiveness against herpes viruses has not yet been established unequivocally. [4]

Chlorhexidine, like other cation-active compounds, remains on the skin. It is frequently combined with alcohols. [2]

Its graphic formula is:



Its most important parameters are shown in Table2 .

Table 2: *Typical properties of Chlorhexidine digluconate.*

properties	amounts
Appearance at 25°C	Almost colorless or pale yellow, Clear liquid
pH, 5% aqueous	Between 5.5 - 7.0
Specific gravity, g/ml	Between 1.06 and 1.07
Assay by HPLC	Not less than 19.0% and Not more than 21.0% of $C_{22}H_{30}C_{12}N_{10}.2C_6H_{12}O_7$ (w/v)

Surface tension is determined with the help of conducting laboratory experiments which test the temperature dependence on surface tension. On Fig. 1 there is a laboratory apparatus for measuring a surface tension which we used.

Fig. 1 *Laboratory apparatus for measuring a surface tension.*

1- container for the tested substance
2- thermostat with a circulating pump
3- faucet, connected to atmosphere
4- faucet, connected to water manometer
5- capillary tube
6- water manometer

An original solution to keep the tests at a certain temperature is suggested. It is realized with the construction and shape of the container in which the tested probe is poured. It is heated with a serpentine, located in the container, through which a circulating pump moves water with temperature, determined in advance and kept the same by a thermostat.

The methodology of defining surface tension is using the method of blowing a bubble in the capillary[8, 9]. The formula for calculation surface tension is expressed by the following relation/1/:

$$\sigma = \sigma_0 \frac{H - h}{H_0 - h} \quad (1),$$

Where σ- surface tension of the tested solution, N/m

σ_0-surface tension of the solvent, N/m

H- manometric tension/pressure in water manometer of the test, mm

H_0 - manometric tension/ pressure of the solvent, mm

h- depth of capillary diving, mm

Distilled water is used as a solvent of disinfectants. Temperature relation to surface tension is studied at the intervals from 10 to 40 Degrees C with concentration of 3 to 10%.

Experimental results and their consideration:

1/ Research results of the influence of temperature upon surface tension value at different constant concentrations.

The Charts of Fig. 2 and Fig. 3 show how surface tension depends on temperature respectively BTC- 50E and Clorhexidine gluconate.

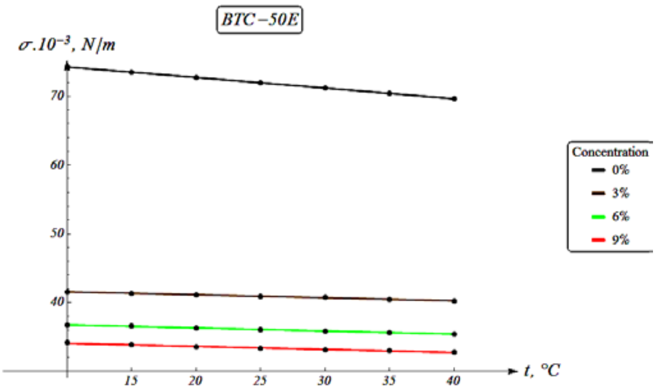


***Fig. 2** BTC- 50E and its surface tension dependence on temperature.*

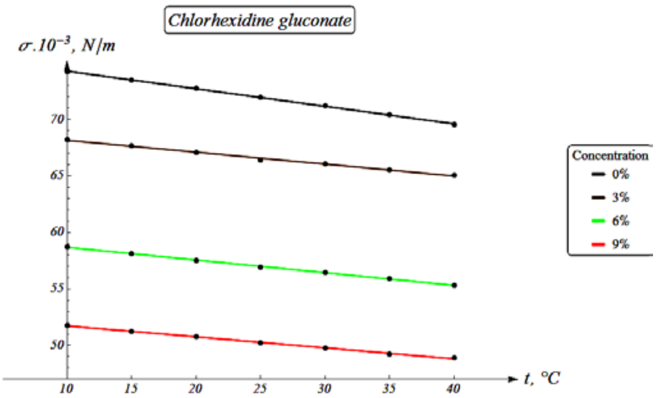


***Fig. 3** Clorhexidine gluconate and its surface tension dependence on temperature.*

Research results of the influence of concentration on surface tension value at different constant temperature.

The Charts of Fig. 4 and Fig. 5 show the relation between surface tension and concentration respectively BTC- 50 E and Clorhexidine gluconate.

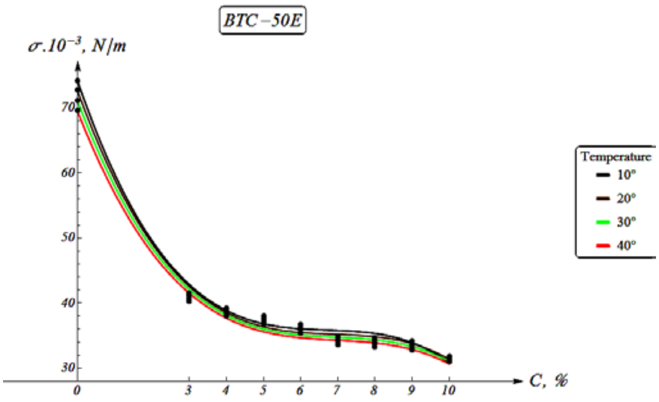


***Fig. 4** Dependence of surface tension (σ) on concentration(C) in BTC-50E.*

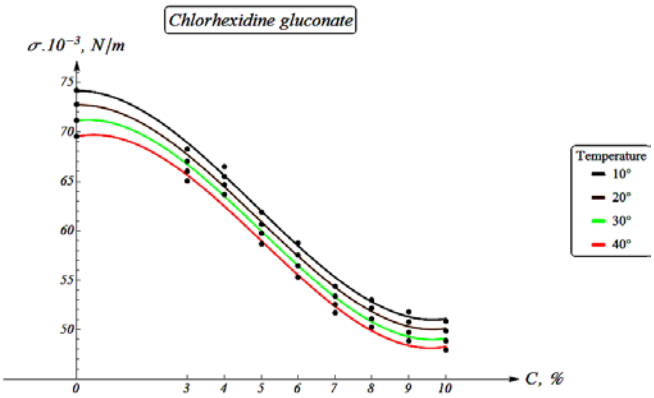


***Fig. 5** Dependence of surface tension (σ) on concentration(C) in Clorhexidine gluconate.*

After some statistics data processing of the results, represented in Fig. from 3 to 10 dependence on temperature – concentration the following regression equations are presented:

***Table 3.** Dependence on temperature – concentration 0% (Clorhexidine gluconate)*

σ= a-bt				
parameter	estimate	standard error	t(5)- statistics	p- value
a	75.823214	0.038609	1963.851751	<0.001
b	0.155500	0.001434	-108.444094	<0.001

***Table 4.** Dependence on temperature – concentration 3% (Clorhexidine gluconate)*

σ= a-bt				
parameter	estimate	standard error	t(5)- statistics	p- value
a	69.20642	0.085649	808.020191	<0.001
b	0.105286	0.003181	-33.098951	<0.001

Table 5. *Dependence on temperature – concentration 6% (Clorhexidine gluconate)*

σ= a-bt				
parameter	estimate	standard error	t(5)- statistics	p- value
a	59.805004	0.049109	1217.790913	<0.001
b	0.112428	0.001824	-61.642597	<0.001

Table 6. *Dependence on temperature – concentration 9% (Clorhexidine gluconate)*

σ= a-bt				
parameter	estimate	standard error	t(5)- statistics	p- value
a	52.702504	0.053845	978.785709	<0.001
b	0.097357	0.001999	-48.684782	<0.001

Table 7. *Dependence on temperature – concentration 0% (BTC-50E)*

σ= a-bt				
a	75.81500	0.032955	2300.573676	< 0.001
b	0.154428	0.001224	−126.176264	< 0.001

Table 8. *Dependence on temperature – concentration 3% (BTC-50E)*

σ= a-bt				
a	41.99	0.017008	2468.993	< 0.001
b	0.043	0.000632	−68.8674	< 0.001

Table 9. *Dependence on temperature – concentration 6% (BTC-50E)*

σ= a-bt				
a	37.20	0.020768	1791.252	< 0.001
b	0.044	0.000771	−57.8802	< 0.001

Table 10. *Dependence on temperature – concentration 9% (BTC-50E)*

σ= a-bt				
a	34.52	0.055309	624.1780	< 0.001
b	0.045	0.002054	−21.9420	< 0.001

After some statistics data processing of the results, represented in Figures from 11 to 18 dependence on concentration – temperature the following regression equations are presented:

Table 11. *Dependence on concentration – temperature 10°C (Clorhexidine gluconate)*

$\sigma = a+bC+cC^2+dC^3$				
a	74.17171	0.7183	103.2472	< 0.0
b	0.041077	0.6174	0.066528	0.949
c	−0.75493	0.1533	−4.92277	0.004
d	0.052007	0.0101	5.125198	0.004

Table 12. *Dependence on concentration – temperature 20°C (Clorhexidine gluconate)*

$\sigma = a+bC+cC^2+dC^3$				
a	72.715677	0.739386	98.345973	< 0.001
b	0.142418	0.635488	0.224109	0.831
c	−0.760631	0.157838	−4.819063	0.005
d	0.052050	0.010444	4.983751	0.004

Table 13. *Dependence on concentration – temperature 30°C (Clorhexidine gluconate)*

$\sigma = a+bC+cC^2+dC^3$				
a	71.14906	0.7442	95.59918	< 0.0
b	0.468448	0.6396	0.732336	0.497
c	−0.81409	0.1588	−5.12410	0.004
d	0.054686	0.0105	5.201988	0.003

Table 14. *Dependence on concentration – temperature 40°C (Clorhexidine gluconate)*

$\sigma = a+bC+cC^2+dC^3$				
a	69.54985	0.7360	94.49295	< 0.0
b	0.738862	0.6326	1.167967	0.295
c	−0.85292	0.1571	−5.42839	0.003
d	0.056638	0.0103	5.447759	0.003

Table 15. *Dependence on concentration – temperature 10°C (BTC-50E)*

$\sigma = a+bC+cC^2+dC^3$				
a	74.02734	1.0091	73.35783	< 0.0
b	−16.6408	0.8673	−19.1863	< 0.0
c	2.447992	0.2154	11.36381	< 0.0
d	−0.12159	0.0142	−8.53030	< 0.0

Table 16. *Dependence on concentration – temperature 20°C (BTC-50E)*

$\sigma = a+bC+cC^2+dC^3$				
a	72.51868	1.0333	70.17618	< 0.0
b	−15.7569	0.8881	−17.7409	< 0.0
c	2.246856	0.2205	10.18532	< 0.0
d	−0.10827	0.0145	−7.41788	0.001

Table 17. *Dependence on concentration – temperature 30°C (BTC-50E)*

$\sigma = a+bC+cC^2+dC^3$				
a	70.97618	1.0022	70.81453	< 0.0
b	−15.1400	0.8614	−17.5752	< 0.0
c	2.144242	0.2139	10.02175	< 0.0
d	−0.10299	0.0141	−7.27498	0.001

Table 18. *Dependence on concentration – temperature 40°C (BTC-50E)*

$\sigma = a + bC + cC^2 + dC^3$				
a	69.38927	0.9563	72.55758	< 0.0
b	−14.5553	0.8219	−17.7083	< 0.0
c	2.050705	0.2041	10.04508	< 0.0
d	−0.09826	0.0135	−7.27450	0.001

The values of specific constants and crucial temperatures are obtained in accordance with the help of the reached regression coefficients of from 3 to 10 on the base of experimental data for each of the solutions and given in advance constant concentration.

Regression correlations from 11 to 18 give the opportunity for acquiring information about temperature dependence of surface tension with other concentrations indirectly.

Figures 4 and 5 give data in accordance to surface active substances whose increasing is not advisable because of its economic effect.

Conclusion:

1. A new formulation of experimental research study is developed dealing with temperature and its relation to disinfecting solutions.
2. Regression correlations, reporting the influence of temperature and concentration on surface tension of water solutions of BTC- 50 E and Clorhexidine gluconate, are obtained and they are applicable to producing disinfectants as well as to assessing their operating qualities.

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